Semi-Annual Report

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MULTIDISCIPLINARY SPACE-RELATED RESEARCH

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The Pennsylvania State University
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Semi-Annual Report on
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Multidisciplinary Space-Related Research

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Multidisciplinary Space-Related Research

1.0 Introduction

Effective September 1, 1965, the National Aeronautics and Space Administration awarded a step-funded grant in the amount of $600,000.00 to The Pennsylvania State University to support a broad-based multidisciplinary space-related program of research.

Immediately after receipt of the grant the Scientific Advisory Committee reviewed a large number of possible sub-projects or tasks proposed by faculty members and selected those reviewed in the following section. These programs have been initiated with varying speeds depending upon the availability of graduate students and the scheduling of time commitments of faculty. At this point all programs are being pursued with full vigor.

The tasks established have, for the most part, involved enhancement of strong existing research efforts with a redirection toward space-related subject matter. In some cases, young new staff are being supported in an effort toward "seeding" embryonic programs with the thought that they can attract independent support within a period of two or three years.

2.0 Funded Tasks

BIOSCIENCE

STUDIES OF ACCLIMATION AND TOLERANCE OF ORGANISMS TO ACUTE STRESSES
Dr. Adam Anthony, Professor of Zoology

In keeping with our broad aim which is to clarify the subcellular, cellular and tissue mechanisms of adaptation to unusual environmental stresses, we have initiated research along several separate but related lines - the cytochemical assay of tissue constituents, polarographic analyses of cellular energetics and histophysiological analyses of organ-system alterations in animals exposed to hypoxia and to cold.

At the present time progress has largely been limited to the standardization of cytochemical, histochemical and cytophotometric methods which will be used to monitor cellular and systemic responses of animals subjected to acute and chronic environmental stresses. Specifically, some of the noteworthy accomplishments to date can be briefly summarized as follows:

(A) We completed a comparative evaluation of several laboratory constructed and commercial microspectrophotometers with respect to their utility in the spectral characterization and assay of stained cellular constituents in bodily tissues. On the basis of this work we are presently incorporating several design changes in apparatus to make it more useful for our specific needs. During the course of this phase of work a simplified procedure for alignment, calibration and operation was perfected which facilitates the routine cytophotometric analyses of mammalian tissue.

(B) Cytophotometric studies of the pituitary were initiated with emphasis on the role of the thyrotroph cells in the regulation of the thyroid gland during acute and prolonged exposure of animals to reduced oxygen pressures.

(C) Several techniques for the purification and spectral assay of nucleoproteins of brain extracts were checked. This was in preparation for contemplated radiometric studies of alterations in ribonucleic acid (RNA) metabolism in the anterior pituitary gland in animals exposed to various stresses. We are presently awaiting shipment of a scintillation counter which is needed for continuation of this phase of work.

GENERAL SUPPORT FOR BIOPHYSICS
Dr. S. R. Person, Associate Professor of Biophysics

This task provides for the support of one fellow and for the purchase of several pieces of equipment. The areas of research include the effects of radiation on living things, the action of hydrostatic pressure on cells, the effects of weightlessness on deposition of calcium in bones and other tissues and the effects of weightlessness on the growing of certain cultures.

Considerable equipment additions have been made including microashing equipment for studies of bone and tissue, hydrostatic pressure equipment and culture growing apparatus.

Mr. C. D. Lyth has been designated a fellow and is supported in his thesis research on the effects of ionizing radiation on the development or maturation of bacterial viruses.

SILICATE-BIO-ORGANIC PROJECT
Dr. G. W. Brindley, Professor of Solid State Technology

1. Personnel: Mr. T. D. Thompson was appointed 1/2 time Graduate Assistant from January 15, 1966.

A Research Associate, post-doctoral level, has not so far been obtained for this project.

2. Research Program: The absorption of a number of purines (adenine, guanine), pyrimidines (uracil, cytosine, thymine), and nucleosides on montmorillonite are being studied. Preliminary data by x-ray diffraction, UV-absorption, and IR absorption, are being obtained. In particular, the effects of different exchangeable cations in the silicate on the absorption characteristics are under examination. Present results indicate little or no absorption of adenine from dilute neutral aqueous solutions. Solutions with a range of pH values from about 2-11 are being prepared.

The long-range objective of the study is to evaluate the possibility that organic materials of the kinds involved in the formation of living materials may have been concentrated and developed through their association with fine-grained, and therefore large-surface, silicate minerals.

COMMUNICATION AND NAVIGATION

JOSEPHSON TUNNELING FOR DEVELOPMENT OF A HIGH SIGNAL-TO-NOISE INSTRUMENT FOR THE MEASUREMENT OF MICROWAVE AND INFRARED RADIATION IN SPACE

Dr. F. G. Brickwedde, Professor of Physics

Work began 1 January 1966 with the appointment of Mr. Vito Russo, a first-year graduate student in physics, as a half-time graduate assistant. The construction of apparatus for depositing films (1000 Angstroms) of superconducting metals for making Josephson Tunnel junctions is our first task. A study was made of film depositing apparatuses and ancillary vacuum systems for them. Decisions have been reached on the purchase of some parts of the system and quotations on these parts have been requested. They now are being received. Some parts will be constructed in Penn State machine shops. Parts will be assembled and connected in our laboratory.

Consideration has been given to other phases of the project. These are:

(1) The method for determining the thickness of the metal oxide layer (about 20 Angstroms thick) that separates the two superconducting metals of a Josephson junction.

(2) Apparatus for measurements of tunneling currents (milliamperes) and voltages (millivolts) across the junction.

(3) The mathematical theory of Josephson tunneling.

FEASIBILITY STUDY OF TWO SPACE COMMUNICATION DEVICES

Dr. Gerard Lachs, Assistant Professor of Electrical Engineering

This project concerns the investigation of two devices potentially useful for space communications. The first is an F. M. modulator of laser beams. This device is based on a modulation controlled doppler shift. It is accomplished by attaching a mirror to a crystal which transduces electrical signals into mechanical vibrations. The second device is a matched filter which will operate at optical frequencies. In this device a diffraction grating is used in place of a tapped delay line.

The work so far has been concentrated on the first of these devices. At present we are concentrating on how high a modulating frequency we can use and as yet we have not been concerned with bandwidths.

At modulating frequencies up to 5 K. C. we have obtained B's greater than 15. At present we are limited by the frequency response of our detectors. We are changing our detectors to photo multipliers and we expect to be able to operate at megacycle modulating frequencies in the near future.

VEHICLE RE-ENTRY IONIZED WAKES

Dr. J. L. Lumley, Professor of Aeronautical Engineering

During entry into the atmosphere, a hypersonic vehicle forms an ionized wake, which, far behind the body, becomes turbulent. The turbulent transport of ionized gas in this part of the wake produces a characteristic microwave or radar signature. In this investigation, an attempt will be made to relate the signature to the parameters of the body producing the wake.

As a result of the conditions of availability of a suitable graduate student , work on this project did not begin until the beginning of the Winter term. Mr. Raphael D. Cahn, a student of considerable maturity and experience in experimental turbulence research, has now been assigned to this project. Mr. Cahn is a trainee under the program in Hydrodynamics of Submerged Bodies. We do not yet have an assistant for him, but we expect to appoint one from the incoming group of students in the Fall. Dr. Vasudeva, a specialist in turbulence measurement, has been given immediate supervisory responsibility for the initial phases of the work; Dr. Payne, who is joining our staff in the Spring term, has had experience with the computational aspects of the work, and will be given supervisory responsibility for that phase.

To date, preliminary design calculations have been made for the experimental facility. It has been tentatively determined that it will be feasible to use a substantial part of an existing design, for which drawings and cost estimates already exist. It is expected that it will be possible to begin construction of at least part of the facility in the near future.

GEOPHYSICS AND ASTRONOMY

MOLECULAR-EFFUSION MASS SPECTROMETRY

Dr. B. R. F. Kendall, Associate Professor of Physics

A new method for analyzing gases at low pressures is being investigated. It is based on differences in the effusion rates of molecules of different gases passing through special metallic membranes containing microscopic pores. Theory suggests that the method would be effective at pressures similar to those now thought to exist on Mars (3-7mb).

A complete analyzer of this type consists of two main parts: the effusion section and the data processing section. An experimental effusion section has been designed and is now nearing completion. Preliminary experiments with a special analog data processing system have given encouraging results. Tests are now being made with various digital computer programs in an attempt to evaluate the relative advantages of the analog and digital techniques.

BOMBARDMENT DAMAGE TO METAL SURFACES BY HEAVY ATOMS ENCOUNTERED IN LOW DENSITY AT ORBITAL FLIGHTS

Dr. E. W. Mueller, Professor of Physics

The subject of this research is the study of the impact of heavy atoms in the upper atmosphere on metal surfaces when such a surface is moving in low altitude orbital flight. Using available rocket data on the density of argon atoms at 140 km altitude, we calculated the expected flux encountered in a circular orbit as a function of the altitude parameter x = altitude/earth radius to be

$$\phi = \frac{1.46 \cdot 10^{23}}{(1+x)^{1/2}} \cdot \left(\frac{1+x}{1+61x}\right)^{20.2} \ (\text{cm}^{-2}\text{sec}^{-1}) \qquad (1)$$

The impact energy, besides the small thermal contribution, is

$$E = \frac{13.1}{1+x} \ (\text{electron-volts}) \qquad (2)$$

From eq. (1) the flux is 8×10^{15} argon atoms $\text{cm}^{-2}\ \text{sec}^{-1}$ at 140 km and 10^5 times less at 400 km. Using as intended a field ion microscope tip of 10^{-10} cm^2 surface area we expect at 140 km

altitude to hit each metal atom at the surface 8 times in a second. At 400 km altitude there will still be 8 impacts on the entire tip area. The impact energy according to eq. 2 is near 12 ev, and thereby above published values of sputtering thresholds.

Being now convinced of the feasibility we are in the process of constructing a suitable field ion microscope for the study of atomic damage by argon near threshold energy. Our planned design of a newly conceived dynamic gas supply had to be abandoned as the fused capillary array, a vital part of this design had suddenly been classified. We are now constructing a somewhat less efficient and convenient system, with two experienced graduate students conducting the experimental set up.

PLANETARY AND STELLAR ATMOSPHERES N_2

Dr. D. H. Rank, Professor of Physics

Ground observations have yielded much information concerning the determination of planetary and stellar atmospheres. In general these results have been confirmed by ballon, rocket, and fly-by space probes. However, one molecule which contributes the vast majority to our atmosphere, and presumably to that of other planets and stellar systems, has not been observed except by its electronic spectra and by inference from its effect in broadening the spectra of other gases. This molecule, N_2, is the fifth most abundant cosmic element, and should be important in any stellar system. Therefore, its ground state spectrum should be known to determine abundances where its electron spectra is not excited.

The proposed method of observation would be the detection of its fundamental quadrupole spectrum at 4.3 microns or at harmonics of this wave length. The molecular constants and some data on its broadening characteristics are known from electronic spectra and Raman spectra. The remaining problem is the path required to produce this weak ground state absorption.

Modification of the 44 meter multiple reflection absorption tube is currently in progress. The modifications involve a more complete purging and pumping system. Several of the optical components have been replaced so that either sapphire or calcium floride windows or lenses are available for the optical

elements. This modification was necessary in order to operate the absorption tube at 4 microns. A special indium antimonide detector for the 4 to 5 micron region has been ordered. A new 10 inch wide diffraction grating of the highest quality and brightness has been installed in the spectrograph and the spectrograph re-calibrated. Upon completion of all the modifications it requires only a relatively short time in order to do the proposed experiments.

A 36 gc. TRAVELING WAVE MASER

Dr. J. P. Hagen, Professor of Radio Astronomy

Due to difficulties in high frequency techniques, the amount of data taken at wave lengths less than one centimeter is meager. The basic instrumentation problem is that of separating the signal noise being investigated from the unwanted noise generated in the receiver itself at high frequencies.

A traveling wave MASER for very low noise amplification at 36 gc. to be used in radio astronomy investigations has been designed. Rutile doped with C_r^{+3} will be used for the active material. A super-conducting magnet will be used to produce the high magnetic field. The complete system will operate at liquid helium temperatures. The slow wave structure is to be simply a reduced size waveguide with the high dielectric constant of rutile providing the slowing. A choice of magnetic field, crystal orientation and operating frequency was made to maximize gain by providing both double ion site operation and push pull pumping.

The pump klystron, waveguide hardware, rutile boules and helium and nitrogen storage dewers have been received from the vendors. The superconducting magnet and working dewer are still on order. The rutile boules must still be machined to the proper size for the slow wave structure.

Work is progressing to obtain the optimum method of impedence matching into and out of the slow wave structure.

FEASIBILITY STUDY OF AN ACCOMMODATION COEFFICIENT FACILITY

Dr. D.P. Hoult, Associate Professor of Aeronautical Engineering
Dr. B. H. Carson, Assistant Professor of Aeronautical Engineering

This program concerns a design study of a device to measure thermal accommodation coefficients. Such a facility would measure the low energy scattering phenomena when a neutral gas molecule with about 1/40 ev impinges on a solid surface. Knowledge of such processes is of fundamental importance in the operation of high altitude probes, as this scattering process forms the surface boundary condition for statistical mechanical equations of the plasma.

This study is presently being conducted along two lines. The first objective is the determination as to whether the state of the art in thermal and momentum accommodation coefficient measurement techniques can be measurably improved and adapted to the direct determination of incident and reflected particle distribution functions for a general class of gas-solid interactions.

A parallel theoretical investigation is being carried out which attempts to relax the classical assumptions in regard to theoretical predictions of accommodation coefficients, and is proceeding along quantum-mechanical lines.

Present funding of this study supports two faculty members at one-third time each, and one one-half time doctoral candidate graduate assistant.

LUNAR AND PLANETARY

MATERIALS ASPECTS OF PLANETARY COMPOSITION

Dr. F. Dachille, Associate Professor of Geochemistry
Dr. G. R. Barsch, Associate Professor of Solid State Science

The research to be pursued under this sub-program consists of the following three parts:

(a) Equation of state studies and non-quenchable phase transitions by in-situ measurements

The major effort in this initial period was directed toward the construction of high pressure x-ray units of opposed anvil design.

The first unit just completed is adapted to use 4, 10 and 15 ton ram assemblies in order to accommodate several sample configurations so important for the elimination of pressure gradients. The unit will also be used to develop adequate heating facilities for attaining 500-600°C and therewith being capable of providing x-ray data in high pressure systems identical with those used successfully in this and other laboratories for almost 10 years. Studies of several oxide, sulfide and metallic systems will be made soon.

(b) Measurement of the dependence of the elastic constants of earth-forming materials on hydrostatic pressure

The objective of this program is, first, to measure the elastic constants of earth and meteor-forming materials, such as olivine, spinel and iron-nickel alloys, as a function of hydrostatic pressure and, second, to utilize these data for the analysis of the internal constitution of the planets including the earth, and meteorites. No data could be taken so far because the high pressure equipment that is to replace a setup which has been dismantled recently has not yet arrived due to exceedingly long delivery times. It is expected, however, that the new setup can be put into operation rather soon.

(c) Theoretical investigation into anharmonic physical properties

It is intended to investigate theoretically the stability of Fe-Ni alloys under pressure with respect to phase transitions. This work has not been started because the personnel required has not yet been made available, in agreement with the reduced budget plan approved.

SOLID-VAPOR REACTIONS OF SURFACE MATERIALS IN LUNAR ENVIRONMENTS

Dr. B. E. Knox, Assistant Professor of Solid State Technology
Dr. J. N. Weber, Assistant Professor of Geochemistry
Mr. E. W. White, Research Assistant, Solid State Technology

1. The Species Present in Silicate Vapours

The volatilization of silicate materials from planetary and other surfaces is an important but relatively unknown process. In

this project work is underway to provide basic information about silicate volatilization processes. Our approach is two-pronged: A mass spectrometer is being used to give mass number and relative concentrations of the evaporating species as well as overall rates of volatilization; an infrared spectrometer is used to provide information about the structure of these species. In this project the emphasis is on the naturally-occurring silicates - those which comprise the bulk of the earth's crust - the olivines, pyroxenes, amphiboles, micas and feldspars. The relationships between variables such as vapor species, trace and minor element composition, and mineral structure are also under investigation.

At the present time, no experimental data have been collected. Equipment for constructing the second drift tube for the mass spectrometer has been ordered and most of it received. A new high temperature furnace for vaporizing the silicates directly in the ion source of the mass spectrometer has been designed, built and tested. Many of the natural minerals have been collected. Within a few months the new drift tube will be in operation. Construction of apparatus for the infrared studies has also been undertaken and is nearly completed. The high temperature vapor phase attachment has been designed. The supporting frame and related components have been built and the spectrometer itself re-mounted. The NaCl and CaF_2 prisms are currently being calibrated.

2. Lunar Water Resources

The time-of-flight mass spectrometer used in silicate vaporization studies is also being used to study the dehydroxylation reaction of certain hydrous minerals such as talc, serpentine and chlorite. Data collection depends upon the completion of the second drift tube for the mass spectrometer. No other special equipment is involved.

3. Effect of Solar Wind on Surface Materials

The areas under investigation in this phase of the project are the mechanisms of proton capture by different mineral structures, the effect of proton bombardment on the kinetics of dehydroxylation reactions and proton luminescence. A proton source for

simulation of the solar wind is in the design stage. This study will be conducted in conjunction with another investigation sponsored by this NASA Grant. Equipment is being constructed jointly by both groups and should be in operation by summer. The mass spectrometer described above will also be used in this study.

STUDY OF LUNAR AND PLANETARY MATERIALS

Dr. Vladmir Vand, Professor of Crystallography

During this project period, emphasis has been on the design and assembly of specialized equipment for an investigation of luminescence of probable lunar surface mineral phase assemblages. Routine operation for a standard fluorescence attachment to a Beckman DK-2A spectrophotometer employs the use of an excitation source, sample holder and focusing mirror, the measurements being taken at atmospheric pressure; however, these specifications have been modified and simplified to allow vacuum operation conditions and the elimination of the focusing mirror which otherwise would require repeated calibration due to deposition of sputtered material.

The primary assembly is an luminescence attachment for the spectrophotometer, providing the capability of interchanging ion sources so as to allow proton, plasma and electron irradiation of a specimem and simultaneous recording of the luminescence spectra. To simulate solar wind cnnditions, the sources are designed to operate at an accelerating potential of 2 KeV with a beam current of several milliamperes.

The vacuum specimen chamber butts up to the spectrophotometer, replacing the light source so that the luminescing specimen serves as the source. Rapid sample changing is effected through utilization of large O-ring type quick connectors, A thin-sectioned specimen is inserted, at a 45^{o} angle to the instrument entrance port, into a slot in a water-cooled copper finger which is positioned through an O-ring type quick connector.

The chamber has the ion source attached at the top; this source is continually pumped by a Welch turbo-molecular pumping assembly capable of achieving 10^{-9} torr, and can be isolated from the sample chamber during the sample changing procedure. In addition, provisions have been made for temperature monitoring of the specimens during irradiation.

A separate secondary test chamber has been constructed for evaluation of the luminescence properties of bulk specimens prior to thin-sectioning of these specimens, thus permitting a rapid preliminary survey. The principle of operation is a cold cathode discharge whereby the specimen is irradiated with electrons and positive ions. The vacuum chamber will accommodate specimens up to approximately 50 millimeters in diameter.

The initial series of research specimens includes a suite of meteorites from The Pennsylvania State University Genth Meteorite Collection. In addition, arrangements have been made for use of an extensive series of meteorite thin-sections from the meteorite collection of the Smithsonian Institution of Washington, D. C.

METEOROLOGICAL

RELATION BETWEEN SATELLITE INDEX AND PRECIPITATION AND TIROS BACKSCATTER CORRELATION WITH OPACITY

Dr. Hans Panofsky, Professor of Meteorology

The first part of this project has to do with an investigation of the relation between an index, derivable from satellite data, with various indications for precipitation. Prior studies have indicated the possibility of a relation between the satellite index and precipitation probability within the next 6 to 12 hours.

The second study has to do with a correlation of satellite backscatter measurements at 5000A, with opacity measurements conducted throughout the United States at the same wave length. These measurements of opacity are believed to indicate large scale air pollution which can possibly be increasing the reflecting power (albedo) of the atmosphere, thus causing a progressively cooler climate. If correlation between the tiros measurements and the opacity measurements is large, air pollution may well be leading us to important climatic changes.

During this reporting period, literature was surveyed relative to the precipitation-run off relationships. Watersheds were selected which appeared suitable for correlation with infrared

satellite data. The literature covering weather satellites was surveyed with special emphasis on the synoptic applications of infrared radiation amounts.

MATERIALS

STUDY OF RADIATION-INDUCED STABILITY OF THE RARE GAS CLATHRATES OF HYDROQUINONE

Dr. W. S. Diethorn, Associate Professor of Nuclear Engineering

Scope

To study the radiation and thermal stability of the argon and krypton clathrates of hydroquinone.

Introduction

Argon, xenon, and krypton form an interesting class of compounds with hydroquinone, called a clathrate. Rare gas atoms are trapped in three dimensional molecular cages in the lattice of beta hydroquinone. Previous work in this laboratory showed that the stability of dilute argon clathrate was improved after relatively short radiation exposures[1]. In the current study we expect to clarify the relationship between radiation damage and thermal stability.

Progress Report

This research is the M. S. thesis topic of Mr. K. Lindquist, a candidate for the M. S. degree in Nuclear Engineering. The effort during this six month period was devoted primarily to

1. improvement of apparatus for the synthesis of clathrate
2. construction of apparatus for long-term thermal stability experiments
3. initiation of long-term irradiation experiments with krypton clathrate

Clathrate samples are being prepared for thermal stability and radiation damage experiments planned during the next 6-month period.

All equipment needed in the program is now available.

One brief note has been published[2] and a second note[3] submitted for publication. Both involve work completed before the start of the current program.

References

1. J. W. McClain and W. S. Diethorn, "Thermal and Radiation Stability of the Argon Clathrate of Hydroquinone", Inter. J. of Appl. Radiation and Isotopes 15, p. 151 (1964).

2. R. R. Stottlemyer and W. S. Diethorn, "Preparation of High-Capacity Argon Clathrate of Hydroquinone", Inter. J. Of Appl. Radiation and Isotopes 16, p. 751 (1965).

3. R. R. Stottlemyer and W. S. Diethron, "Thermal Stability of Rare Gas Clathrates of Hydroquinone", submitted for publication.

STUDIES OF PYROLYTIC GRAPHITE

Dr. D. E. Kline, Associate Professor of Nuclear Engineering
Dr. P. L. Walker, Jr., Professor of Fuel Technology

Pyrolytic graphite can be defined as the material produced from the decomposition of carbonaceous gases and the accompanying deposition onto a substrate. At high temperatures the material is characterized by high strength, high emissivity, and low permeability to gases. This makes it applicable to space vehicle structures such as nose cone shields, rocket nozzles and leading edges.

This program will be directed to the following studies:

(a) Characterization and analysis of the dynamic mechanical spectrum of pyrolytic graphite including heat treating and introduction of foreign atoms.

(b) Studies of stress-annealed pyrolytic graphite samples.

(c) Studies of charred polymers.

Dynamic mechanical spectroscopy is generally very sensitive to the microscopic structure of solids. Very little information is presently available on the dynamic mechanical behavior of graphites, particularly pyrolytic graphite (PG). This research was initiated to experimentally determine the dynamic mechanical spectra of selected pyrolytic graphites and to attempt to relate the spectra to the microscopic behavior of the structure.

Changes in the structure will be introduced by heat treatments, nuclear irradiations, and other means, in order to study the effect of structure, defects and foreign species in the lattice. Research is proceeding on the dynamic mechanical spectrum of as-received PG (deposited near 2000°C) over the temperature range 80-800°K. The spectra are being analyzed and correlated with other types of data to develop explanations for the observed behavior. The first research paper in this area of investigation is currently in preparation.

3.0 Pending Obligations, Other Activities and Future Plans

Other programs, which may require the commitment of funds between now and September 1, 1966, include:

(1) Employment of an electro-mechanical design and construction engineer to assist faculty in the design and construction of payloads for space experiments. We are building up a payload and instrument design and construction shop as part of the Ionosphere Research Laboratory. Technician and shop personnel are being added to the staff but our real need is for the type of individual described above - preferably someone who has had prior experience with a company or government laboratory actively engaged in space flight experiments.

(2) A contribution toward the costs of installing and initiating operation of a high-power 200 mc/sec radar at the Radio Astronomy site. This radar will be used to yield information on the surface of the moon, orbit of the moon, the shape and size of the earth (in conjunction with a similar program at NRL)

and some information on the total electron content between earth and moon.

(3) A contribution, together with University and NSF funds, toward the purchase of an electron-microprobe for the Mineral Constitution Laboratories in the College of Mineral Industries.

(4) A contribution toward the purchase of a digital data acquisition system of interest to the Systems and Controls Laboratory and to the Ionosphere Research Laboratory. This, together with funds from the University, will match possible funding for this purchase by the National Science Foundation.

(5) A number of laboratories are inviting distinguished scientists and engineers from space-related fields to visit the campus for a period of one term (12 weeks). These expenses would be covered from grant funds.

(6) Partial support for the salary of a new faculty addition to the Department of Fuel Science. This individual will be involved in cooperative research with the Department of Aeronautical Engineering in the areas of the kinetics and mechanism of high temperature processes with special reference to high energy fuels and hot-gas dynamics and their application to high intensity combustion processes in ram-jets, rocket motors and similar devices.

The Space Science and Engineering Laboratory has sponsored the following two seminars:

Friday, January 28, 1966
Mr. Gerald S. Levy, JPL, Cal. Tech.
"The Mariner Mars Occultation Experiment"

Friday, February 25, 1966
Dr. Hans A. Panofsky, Professor of Meteorology, Penn State
"Progress Report on Weather Satellites"

Plans are being made to hold other similar seminars during the spring term.

Interest is increasing on the part of faculty who did not participate in the initial discussions and program formulation that resulted

in the proposal upon which this grant is based. The Advisory Committee and the Director of the Space Science and Engineering Laboratory have been repeatedly approached by faculty members who have new ideas for research in space-related fields. The present program will exhaust available funds for this first year and it is likely that most programs will be continued for a second year. Without an appreciable increase in the grant for 1966-67 we are unable to give much hope for support to those who are not presently supported yet who have suggested exciting new programs of research.

The program is still too new to have developed any publications based on research results although a number of papers are under preparation.

Due to the reduction of the actual grant as compared to our original proposal we have not directly funded any activity aimed at the dissemination of research results. However, we hope to accomplish this through programs developed under the Pennsylvania Technical Assistance Program funded by the Technical Services Act of 1965 and coordinated by the U. S. Department of Commerce. Developments along this line will be described in future reports.

P. Ebaugh
March 16, 1966